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Abstract

Radio Frequency Identification also known as RFID technology has been commercially available since World War II. Early applications of RFID were for military purposes. In recent years, interest has turned toward supply chain management, such as monitoring and tracking business process. Many global companies have already invested in RFID business solutions. New Zealand has a number of successful pilots. However, it is not clear how New Zealand industry leaders perceive RFID solutions, particularly since the recent negative publicity about RFID in the media. This research explores the current status of RFID adoption among industry representatives in New Zealand using innovation theory to classifying respondents as innovators; early adopters; early majorities; and late majorities to try to provide insight into the role of innovation advocacy groups such as RFID Pathfinder. Moore's innovation theory has been used to categorise the innovativeness of New Zealand industry groups. By implication, Moore's theory is a good tool for technology advocates such as the NZ RFID Pathfinder Group to analyse the current status of adoption of technology in their environment and plan accordingly.

Keywords:

Innovation theory; technology adoption; RFID

Overview

The paper reports on research undertaken with the NZ RFID Pathfinder Group to explore the amount of RFID innovation currently underway in New Zealand and to provide feedback on how the Pathfinder Group can facilitate adoption of RFID technology. The NZ RFID Pathfinder Group was set up in 2006/2007 and has a national committee of eleven members and an individual membership of more than fifty. An official memorandum of understanding was set up between AUT University and The NZ RFID Pathfinder Group to facilitate the development of research projects. This particular research is the first such project.

Literature Review

The literature review firstly investigates Innovation Theory and the Technology Adoption Life Cycle before looking at the current state of RFID adoption around the world. Following this, the paper turns to the unique economic environment in New Zealand and then more specifically, the status of the NZ RFID Pathfinder Group.

Innovation theory

The whole adoption process has five stages as mentioned previously (Rogers, Takegami, & Yin, 2001). Firstly, the process means that the businesses have to be aware of the innovation. If they are interested in the technology, they will form an attitude to the innovation to show interest. The adoption decision will be either accepted or rejected. Once the decision is accepted, the technology will be implemented. The final step in the process is the confirmation of the adoption. The adoption process applies to all kinds of innovation adopters. Overall, the diffusion of innovation process contains four main components: the innovation, communication through certain channels, time, and the members of social system (Moore, 2002).

Diffusion of innovation theory is used to monitor why and how new technologies spread through cultures and at what rate (Rogers 1995). The theory applies to not only technologies but also new ideas. It is anticipated that the adoption of RFID technology by New Zealand businesses will involve all of these segments and processes. As per Moore's theory, the chasm is the critical point at which the success or failure of the RFID technology innovation in the New Zealand market can be determined.

Technology Adoption Life Cycle

According to Moore (2002), most business plans are based on the traditional technology adoption life cycle, which includes: innovators, early adopters, early majority, late majority, and finally laggards (Rogers, Takegami and Yin (2001). It is anticipated that the adoption of RFID technology by New Zealand businesses will involve all of these segments and processes.

Moore's model is also a fundamental model for high-tech marketing. Between each of the groups, there is a gap. The largest gap is considered a chasm, which is between early adopters and the early majority (Moore, 2002). Moore argues that the chasm is the critical point where it is possible to predict whether the high-tech adoption will be a success or a failure.

Other studies to use innovation theory for measurement

There are some other studies that have also used innovation theory for measurement in their research projects. The article entitle "Early adopters of technological innovations" published on the "Latin American Media & Marketing" website (2000) the researcher conducted a survey of 2,003 persons between the ages of 12 and 64 living in the Santiago area. They tried to find out the innovativeness of the locals. They categorised socio-economic status into groups such as A, B, C1, C2, C3 and D against the Moore's innovation theory to identify innovators and early adopters. In the research on "innovation adoption in agriculture: innovators, early adopters and laggards" conducted by Diederen, Meijl, Wolters and Bijak (2003) the researchers used Moore's innovation theory to analyse the choice of a farmer to be an innovator, early adopter or laggard. The survey found that innovators and early adopters differ from laggards with regard to structural characteristics like size, market position, age and solvency. Innovators make more use of external sources of information and they are more involved in the actual development of innovations.

Current state of RFID around the world

Radio Frequency Identification technology is also known as RFID. The technology has been available for many decades. Due to the costs of the technology, the adoption rate has been limited. Since RFID technology has been developed for Supply Chain Management (SCM), the potential of the business applications have been re-emphasised globally. RFID applications have been used for the purpose of monitoring and tracking business process (Maloni & DeWolf 2006). According to the literature, many countries have invested a fortune in RFID technology. For example, in 2007, RFID technology investment in East Asia was US$2.7 billion of US$4.96 billion spent globally. US$1.9 billion of this was just in China (ReportBuyer.com 2007); and the USA has invested even more than China (Xiao 2007). The US market for RFID technology retail supply chain will rise from 91.5 million US Dollars in 2003 to 1.3 billion US Dollars in 2008 (Pharmaceutical International 2008).

Business environment in New Zealand

New Zealand is a relatively small country. According to the Treasury.govt.nz (2008) there are many more small and medium businesses (SMEs) supporting the economy of New Zealand. The significance of the SME sector in New Zealand has increased over the last few years, driven on by opportunities in globalisation and technological development. The Ministry Of Economic Development (2007) provides a database about the enterprise sizes in New Zealand in 2006. The database shows that 63.6% enterprises have 0 employees. Enterprises with 500 or more employees only 0.1%. Less than 5 employees is 23.3%; less than 10 but more than 5 employees is 5.2%; less than 20 but more than 10 employees is 4.3%; and enterprise with less than 500 but more than 20 employees is 3.4%. These figures represent the economy structure of New Zealand and demonstrate that that there are many more SMEs than big companies.

Current state of RFID in New Zealand

New Zealand has shown some leadership in global RFID technology adoption. According to Harrop (2006), New Zealand is well behind a number of countries around the world such as, Botswana, Uruguay and Canada in tagging cattle using RFID. There are several RFID adoption cases in New Zealand so far. According to Industry Search (2006), Fonterra, the world's largest milk cooperative, has appointed system integrators for a major project using of RFID for error prevention and record keeping in New Zealand. According to iStart (2005), The Warehouse has cooperated with IBM NZ to explore how RFID could be used to improve the efficiency of its store management and stock availability for customer since late 2004. Yakka Apparel, clothing supplier to the New Zealand Defence Forces, worked closely with Manufact Data Systems (MDS) to develop an innovative ordering solution by using RFID technology in 2005 (Elmes 2005). They created a software program with an RFID wristband and all the garments were identified with an RFID tag. Traditionally, the sizes of the soldiers were measured and recorded manually. The new system uses a RFID enabled wristband to identify soldiers, and the garments are scanned to identify the sizes. The managing director of MDS, Ian Parker said that RFID

technology brought a significant value to the suppliers as well as the customers by reducing the error rate and speeding up the work flows. Scoop (2005) reported that Botany was the first New Zealand public library to implement an RFID-based intelligent library system. There were 30,000 books tagged with RFID. Using RFID, books are automatically scanned for loans and the library staff can use a handheld scanner to check whether the books are out of sequence on the shelves. The deployment of the RFID library system has given Botany library a 20 percent increase in process efficiency (Scoop 2005).

New Zealand has several high profile RFID implementation projects. However, as noted by Dover (2005) despite RFID pilot projects by companies such as: The Warehouse, Tranz Rail, Progressive and Fonterra, most New Zealand companies are still in a watching and waiting mode. Soon (2007) stated that the RFID adoption rate is low; however, there is a lot of interest in RFID across New Zealand businesses and organisations.

New Zealand Pathfinder Group

New Zealand Pathfinder group became an Incorporated Society on 11th May, 2006. The group campaigns for the competitive development of New Zealand businesses through the adoption of RFID and Electronic Product Code (EPC) technologies. EPC is a series of coding schemes. Arguably the most well known coding scheme is the bar code, which was created as a low-cost method of tracking goods by using RFID technology (EPCglobal 2008). The goal of Pathfinder group is to provide a shared learning approach to RFID technologies and EPC for the businesses in New Zealand and to accelerate the revolutionary vs. evolutionary change management process. They encourage EPC adoptions and knowledge in New Zealand businesses by providing education and conducting awareness campaigns (PathfinderGroup 2008).

Purpose of this project

The aim of this survey was to find out the current status of Radio Frequency Identification (RFID) technology adoption at the industry level in New Zealand and to investigate industry group perceptions of technology advocacy groups such as NZ RFID pathfinder. To achieve these aims, the survey sought to determine at the industry level:

1. Type of RFID technology used in New Zealand
2. Intentions of utilizing RFID technology in the future
3. Innovativeness of the respondents' industry

Methodology

In order to answer the research question proposed in this study it was necessary to firstly survey the New Zealand industry groups about the current state of RFID use and plans for use, plans for future RFID use and attitudes toward a technology advocacy group such as the RFID pathfinder group. A survey method has been chosen as it is most suitable for collecting information from a large number of participants (Kuter & Yilmaz 2001). The questionnaire method has chosen because it is inexpensive to administer, easy to compare and analyse, and administer to many participants (Cohen, Manion & Morrison 2000). The participants were from the management level in the IT field of each industry. The questionnaire consisted 28 questions. It was presented on a website (FreeOnlineSurveys), therefore, the participants could get easy access from anywhere anytime. The online questionnaire was developed according to the Dillman principles for online survey development (Dillman, Tortora, & Bowker 1999).

The RFID use, perceptions and demographics part of the survey instrument was adapted from the GS1 questionnaire from EPC Advisory Group in Australia reported by MacMillan-Davis (2006). These questions were short answer with respondents selecting from set responses using a check box method.

Based on innovation theory, there are six focused areas used to classify innovativeness adopters, such as number of competitors; leadership; the main driver of deployment; regarding new ideas; acknowledgement by the peers; interactive level with the peers (Moore 2002).Therefore, there were six questions developed to classify the adopters. These were:

- Does your company have many competitors?
- Is your company quite often rated among top companies in the industry?
- What will be the main driver for this RFID deployment?
- Is your company always highly regarding new technologies or a new idea?

- What is the attitude of the other similar companies in the industry towards to your company?
- How often do you interact with the peer companies?

Respondents responded to the innovativeness questions using a likert scale. After the final developing stage for the questions, the questionnaire was pre-tested and approved by the Pathfinder group.

There were 57 mail invitations sent out throughout New Zealand according to the list of industry group representatives, which was provided by the Pathfinder group. After two weeks, there was another follow up Email sent to the participants. After period of a month, there were 51 responses received from a variety of industry organisations, which constitutes an 89% response rate.

The questionnaire was branched to ensure that respondents were only asked questions that they could reasonably be expected to respond to. There were three main groups of respondents: businesses who adopted RFID already; businesses that planned to adopt RFID; and businesses that did not intend to adopt RFID. There were 7 respondents in the group of "businesses who adopted RFID"; there were 44 respondents who answered the other questions. The group of "businesses that plan to adopt RFID" had 16 respondents out of the 44 respondents; and the group of "businesses that do not intent to adopt RFID" had 28 respondents out of the 44 respondents.

General Results

Who responded

According to the results (Figure 1), the highest response was from manufacturing industries, which was 34.9%. The least responses group were Packaging and Government (Policy)/Academic Institution/Association, which was only 2.3%. Distribution group was 14%; 3PL/Logistics and Importer groups were 11.6% respectively. Retailer/buyer and Service provider groups were 9.3% individually. The other group included Research Institute and Adventure Tourism and represented 4.7%.

Organisation's primary role in the supply chain

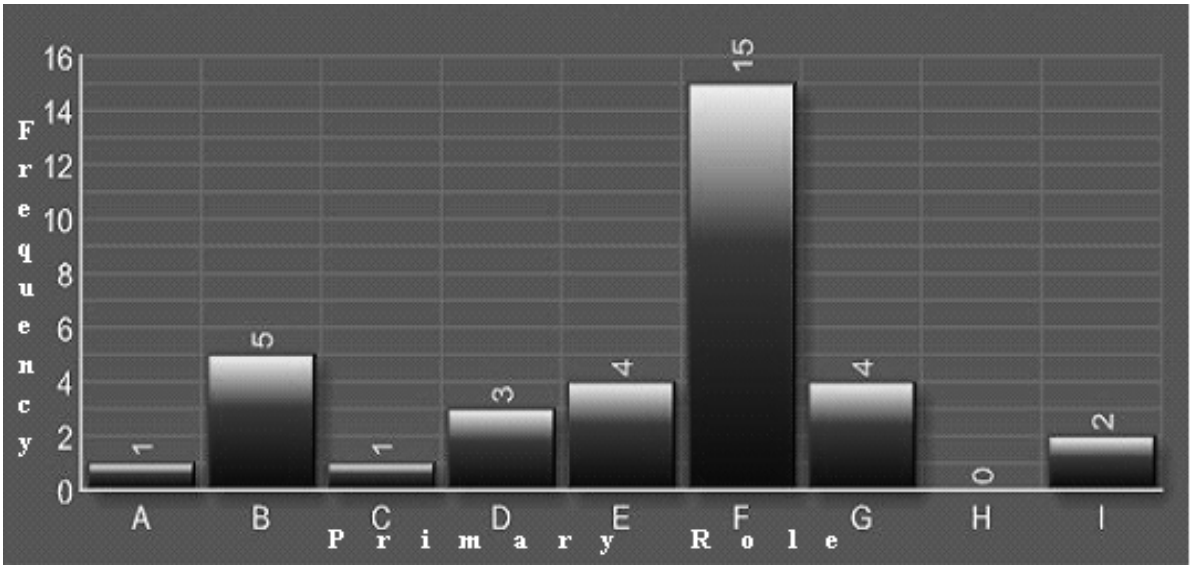

Figure 1: what is your organisation's primary role in the supply chain?

A) Retailer / buyer; B) Distribution; C) Packaging; D) 3PL / logistics; E) Service provider; F) Manufacturer; G) Importer; H) Government (policy) / academic institution / association; I) Other
N[1]=35 (question not compulsory)

1 N = Number of usable responses to this part of the survey.

General background of the participants

All participants responded that they are always highly regarded for taking on new technologies or new ideas. Most of them sometimes interact with the other companies, and they sometimes rated among top companies in their industry. Fifty percent of them had involved in RFID projects previously.

Fifty percent of the respondents were part of an organisation with more than 500 full time employees while the others had less than 100 full time employs. 67% of the respondents thought that RFID education and training should be more about introductory awareness. And they also think the most important activities of the NZ pathfinder group should promote the direction for New Zealand adoption, lobby governments and associations, information sharing, seminars/conferences, field trips, and networking functions. Most of them believe that they are using leading edge technologies compared with the others. Most of the respondents were suppliers in the business supply chain. The idea of using RFID was recommended by their customers' needs, and the main driver for RFID deployment was a successful business case. Fifty percent of respondents intended to use RFID in the company supply chain.

The majority of respondents were interested in RFID Pathfinder group membership. About 70% thought that RFID would support their businesses' future direction. The survey indicated that 40% of the participants had previously had discussions with their customers regarding the use of RFID. About 33.3% of them had discussed with RFID suppliers. 6.7% of participants had no discussion with anyone regarding the use of RFID.

Businesses who adopted RFID already

According to the responses (Figure 2), 50% of respondents intended to use RFID in the supply chain. Only 13.73% of respondent industries had adopted RFID technology. This is an important observation as some of the questions in this survey were aimed specifically at respondents who had adopted RFID technology and so therefore, even though we had a good response overall, the response was not enough to answer some of the more specific questions about RFID adoption in a quantitative manner.

Who deployed RFID technology so far?

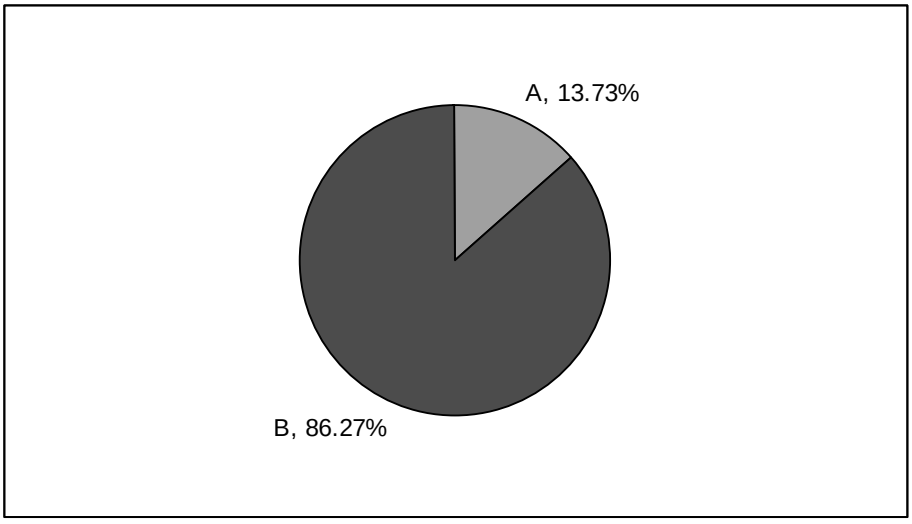

Figure 2: does your company/organization use RFID technology?

A= Yes; B = No

N=51

Businesses that plan to adopt RFID

Out of all the respondents who had not adopted RFID technology, 87% intended to deploy RFID in their operation /supply chain. For the participants who intended to deploy RFID in the future, 33.33% intended to deploy RFID in a production/logistics environment within 1 year; 27.78% intended to deploy RFID within 1 to 2 years; 27.78% intended to deploy RFID within 2 to 4 years; and 11.11% of them have no plan to deploy the technology. According to the survey, 87% of businesses intended to adopt RFID technology, while 54% of them would like to adopt the technology within 2 years time.

Level of knowledge

The survey shows that the majority of the participants, who answered this question, have minor knowledge of RFID (61.11%) (see Figure 3). Only 5.56% of respondents rated themselves as expert in RFID. This result indicates that RFID is not well known, as many businesses do not possess deep knowledge regarding RFID.

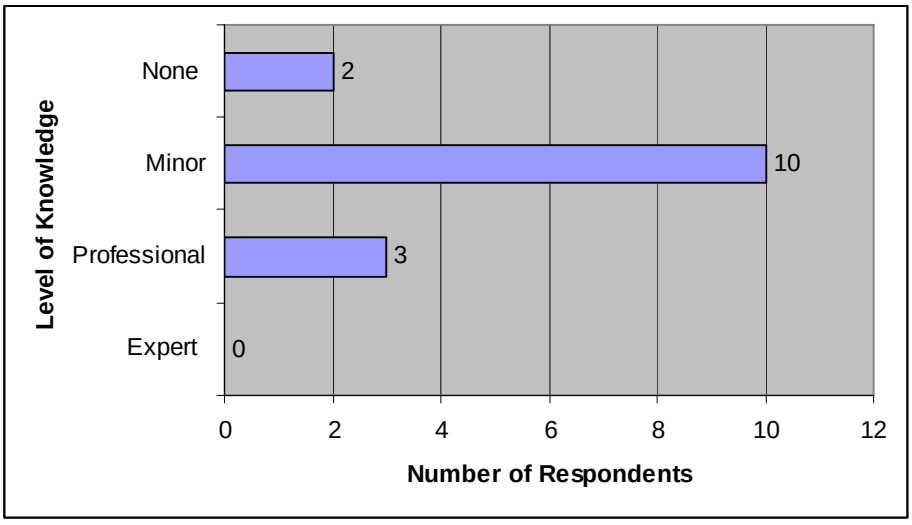

Figure 3: what would you rate your company's knowledge of RFID?

N=15

Activities RFID Pathfinder should undertake

Twenty eight percent of respondents thought that the most important role of the NZ Pathfinder group was to set the direction for NZ adoption (see Figure 4). Respondents also felt that getting involved in national pilots, lobbying governments and associations and information sharing were also highly rated.

Respondents were also invited to indicate the level of RFID training that they would most like to participate in. Introductory/awareness has the highest rate, which was 47.1% out of the responses. Business case/ROI development and RFID technology training were equally rated for 17.6%. Advanced certificate course was rated 11.8%. The education about standards was the least rated one for 5.9%.

Activities NZ Pathfinder should do to promote RFID adoption

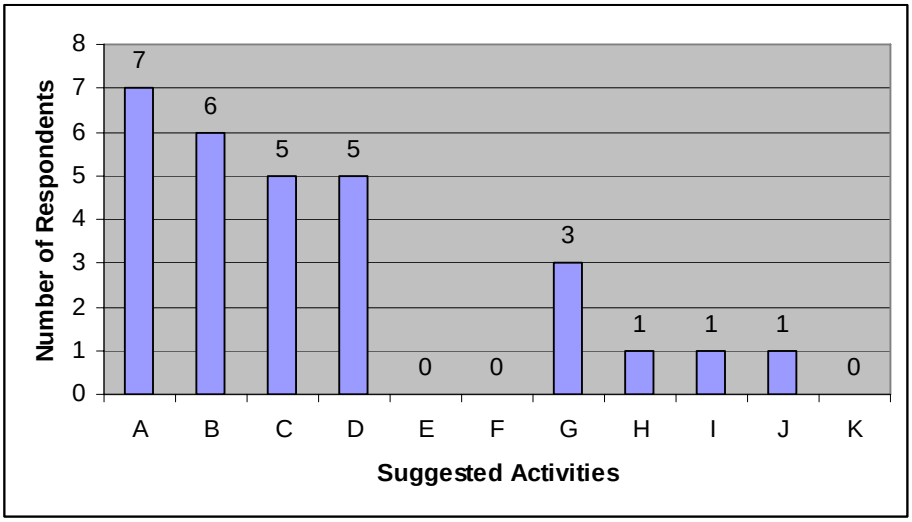

Figure 4: what do you think the most important activities of the NZ Pathfinder group should promote?
A) Set direction for NZ adoption; B) Get involved in national pilots; C) Lobby governments and associations; D) Information sharing; E) Webinars; F) Interactive website; G) Seminars; H) Conferences; I) Field trips; J) Networking functions; K) Other
N=29

Innovativeness

Based on the amount of points given for each of the six innovation questions, the participants were classified as Innovator, Early adopter, Early majority, Late majority, and Laggard. Only six respondents answered this section. One set of responses was removed because the respondent did not answer all questions. Of the people who did respond, one industry participant was classified as an innovator, three were classified as early adopters and one was classified as early majority.

Discussion

The sample size of this study means that any analysis must be made cautiously and must be backed up with further study. However, we made some preliminary comments based on the data already collected. We note that the number of New Zealand industry groups who report adopting RFID is still very low. The self reported knowledge and awareness of RFID is still limited with only pockets of RFID expert knowledge, the demand for RFID training in New Zealand is predominantly at the introductory awareness stage and the measure of innovativeness of those industry groups reporting to have adopted RFID shows the level to be at Innovator, Early adopter or Early majority with most of these being classified as Early adopter.

Conclusion

Our preliminary comments based on data already collected suggests that there are three main industry positions regarding RFID adoption in New Zealand: industry groups that adopted RFID already; industry groups that plan to adopt RFID in the short future; and the industry groups that have no intention to adopt RFID at all. This research also shows that innovation theory is useful to analyse the innovativeness of technology adoption in industry.

There are some industry groups that have already adopted RFID technologies for their supply chain or they have plans to adopt RFID technologies in the short future. However, they are just a small portion of industry groups in New Zealand and RFID technologies are still very new to the decision makers. There are still a lot of players to come once the early majority starts to realize the importance of the RFID technologies.

Limitations

There are several limitations of the study that must be acknowledged. Firstly, the list of industry representatives for the online survey was given by Pathfinder group from their database based on a list of

industry groups provided by New Zealand Trade and Enterprise. In the selection of industry representatives, which is based on networking contacts, it is possible that they sample as biased.

Secondly, this research project was one year long and represents a very small portion of the RFID development path. It can only capture a "snapshot" of New Zealand RFID adoption. In order to monitor the process of RFID technologies improvement in New Zealand, future research is required to update the results. Therefore, future updates to this study are important and researchers may take a longitudinal approach to this research problem in the future.

Implications

The analysis of the research data was based on Moore's innovation theory. For academia, this study corroborates with many others to show that Moore's theory provides guidance for academic study of the current businesses status of technology innovations.

For industry, Moore's innovation theory has shown itself to be a useful measurement of innovativeness and a useful way to explain the technology adoption life cycle in practice. Moore's theory emphasises that the Chasm is the critical period for any kind of new technology adoption. If the industries can understand the innovation theory and apply the theory, they can gain insight into their position as well as their competitors' position in the market. They can also plan for their future based on their own technology adoption life cycle stage and therefore be more competitive. By implication, Moore's theory is a good tool for businesses to analysis themselves with the current business market, so they can plan their future.

Future research

Future research should try to classify the whole sample population for innovativeness, not just the participants that had adopted RFID as we did with our survey. This would help to verify the full measure of innovativeness and to develop the measure further so that it can be used more widely.

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